Abstract

The present thesis employs fuzzy-polynomial control techniques in order to improve the stability analysis and control of nonlinear systems. Initially, it reviews the more extended techniques in the field of Takagi-Sugeno fuzzy systems, such as the more relevant results about polynomial and fuzzy polynomial systems. The basic framework uses fuzzy polynomial models by Taylor series and sum-of-squares techniques (semidefinite programming) in order to obtain stability guarantees.

The contributions of the thesis are:

- Improved domain of attraction estimation of nonlinear systems for both continuous-time and discrete-time cases. An iterative methodology based on invariant-set results is presented for obtaining polynomial boundaries of such domain of attraction.

- Extension of the above problem to the case with bounded persistent disturbances acting. Different characterizations of inescapable sets with polynomial boundaries are determined.

- State estimation: extension of the previous results in literature to the case of fuzzy observers with polynomial gains, guaranteeing stability of the estimation error and inescapability in a subset of the zone where the model is valid.

- Proposal of a polynomial Lyapunov function with discrete delay in order to improve some polynomial control designs from literature. Preliminary extension to the fuzzy polynomial case.

Last chapters present a preliminary experimental work in order to check and validate the theoretical results on real platforms in the future.